Space Weather Technical Forecast

Issued on Saturday, 06 January 2024 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares with a slight chance of X-flares. CME arrival forecast on 08 or 09 January.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Low, with a peak C3.7 flare observed at 05/0809 UTC from AR3534 in the southwest quadrant. This is one of a number of C-class flares from AR3534, AR3536 and AR3540, which is currently rotating around the southeast limb. There are currently eight sunspot regions on the visible disc, one of which is unnumbered. AR3536 is the most prominent and magnetically complex region, with a persistent delta spot, which is north-south aligned. AR3538 also exhibits beta-gamma characteristics, although has recently shown some minor decay. AR3540 which is currently rotating around southeast limb has now been split into two sunspot regions, with some separation evident in its magnetic field configuration. The southern portion of the region has been newly numbered AR3541, which is a simple Hsx/Alpha configuration. These regions are still difficult to analyse due to foreshortening, with a more accurate analysis to be conducted as it rotates into a better viewing angle. A CME was observed leaving the region of AR3536 at around 04/2300UTC appears to have an Earth-directed component. A further CME observed at around 05/0100UTC appears to have emanated from close to the southeast limb and may have left from the newly emerging region on the limb. No further Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar winds have been slightly elevated averaging 420-480km/s under the waning influence of coronal hole 86. Density has been around average or slightly below. Total interplanetary magnetic field strength, IMF, has been weak, with the north-south component varying weakly. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity has been Quiet (Kp0-2) throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux started above the S1/Minor Storm threshold, with a peak of 25.3pfu at 05/0035UTC, which has yet to be attributed to a specific cause, but has followed a steady decline to below threshold. GOES16 high energy (greater than 2MeV) electron flux was at background levels. The 24-hour fluence was below Active throughout, with a flat trend. The 06/0000 UTC observation was 1.59e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is forecast, with a very slight chance of X-class flaring.

Solar Wind / Geomagnetic Activity: A CME which left the Sun from the northeast quadrant late on 04 January may glance the Earth either late on Day 2 (07 Jan) or during Day 3 (08 Jan). Solar wind speeds are expected to decline to background, with a high speed stream from coronal hole 89 forecast to connect with the Earth either late on Day 2 (07 Jan) or during Day 3 (08 Jan), with estimated speeds of 400-500km/s. Geomagnetic activity is forecast to start Quiet on Day 1 (06 Jan). Unsettled to Active intervals are then possible on Days 2 to 4 (07-09 Jan),

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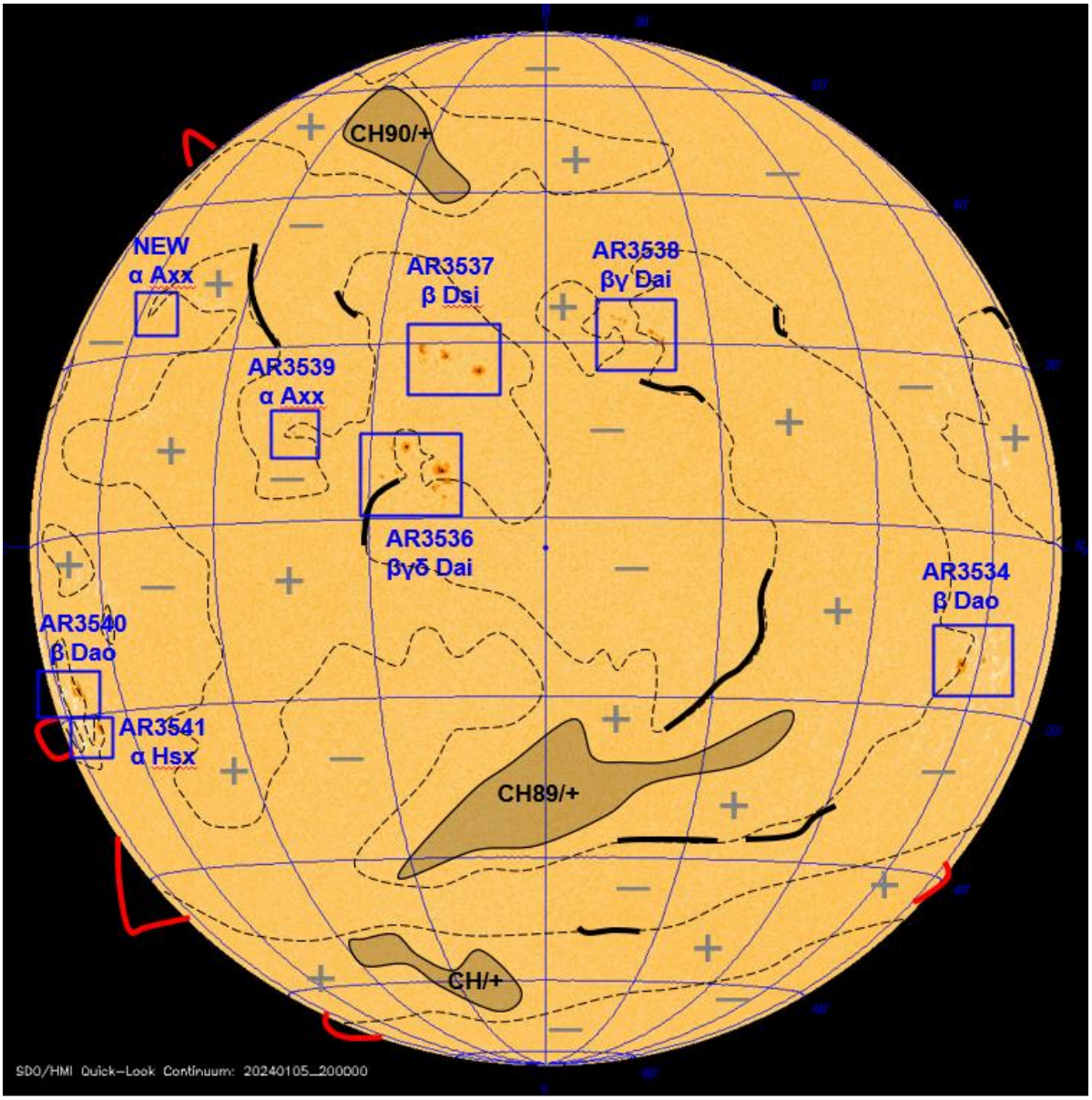
with a slight chance of G1/Minor Storm intervals due either to the high speed stream, CME or a combination of both.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is below the S1/Minor Storm threshold. This is expected to follow a declining trend, but with a risk of further increases above the threshold on 07 or 08 January due to the CME arrival. GOES16 high energy electron flux is likely to remain at predominantly background levels at first, with a chance of Moderate levels later in the period, dependent on the interaction of the coronal hole high speed stream connection and CME arrival, which may keep electrons suppressed throughout the period.

Figure 1. Solar Analysis Valid 05/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Two CMEs have been analysed in the last 24 hours. One was on the eastern limb and is not expected to affect the Earth. A further CME from the northeastern quadrant is forecast to perhaps glance the Earth either late on Day 3 (08 Jan) or during Day 4 (09 Jan), although this is low confidence.

Otherwise, the high speed stream from coronal hole 86 continues to wane. Ambient solar wind speeds are then likely through Day 1 (06 Jan). The high speed stream from coronal hole 89 may then connect with the Earth on Day 2 (07 Jan), with speeds in the region of 400-500km/s possible, these then continuing into Day 3 (08 Jan). This coronal hole is a recurrent feature which produced limited effects on the previous rotation, but which appears to be stronger on this rotation. As the coronal hole high speed stream and CME are forecast to affect the Earth around the same time, there is uncertainty about potential speeds, with the speed of the CME also forecast at around 400-450km/s.

Geomagnetic activity is forecast to be mainly Quiet on Day 1 (06 Jan). There is then a slight chance of Unsettled to Active periods and a very slight chance of G1/Minor storms on Days 2 -4 (07-09 Jan) due to the potential coincident arrival of the high speed stream and CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	15	15	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
05/0986	Partial	Filament eruption	NE quadrant	400-450km/s	08/1200 UTC +/- 12 hours	Glancing shock possible. Low confidence.

Figure 2: MOSWOC Enlil model showing the anticipated time of CME arrival (highlighted by yellow circle).

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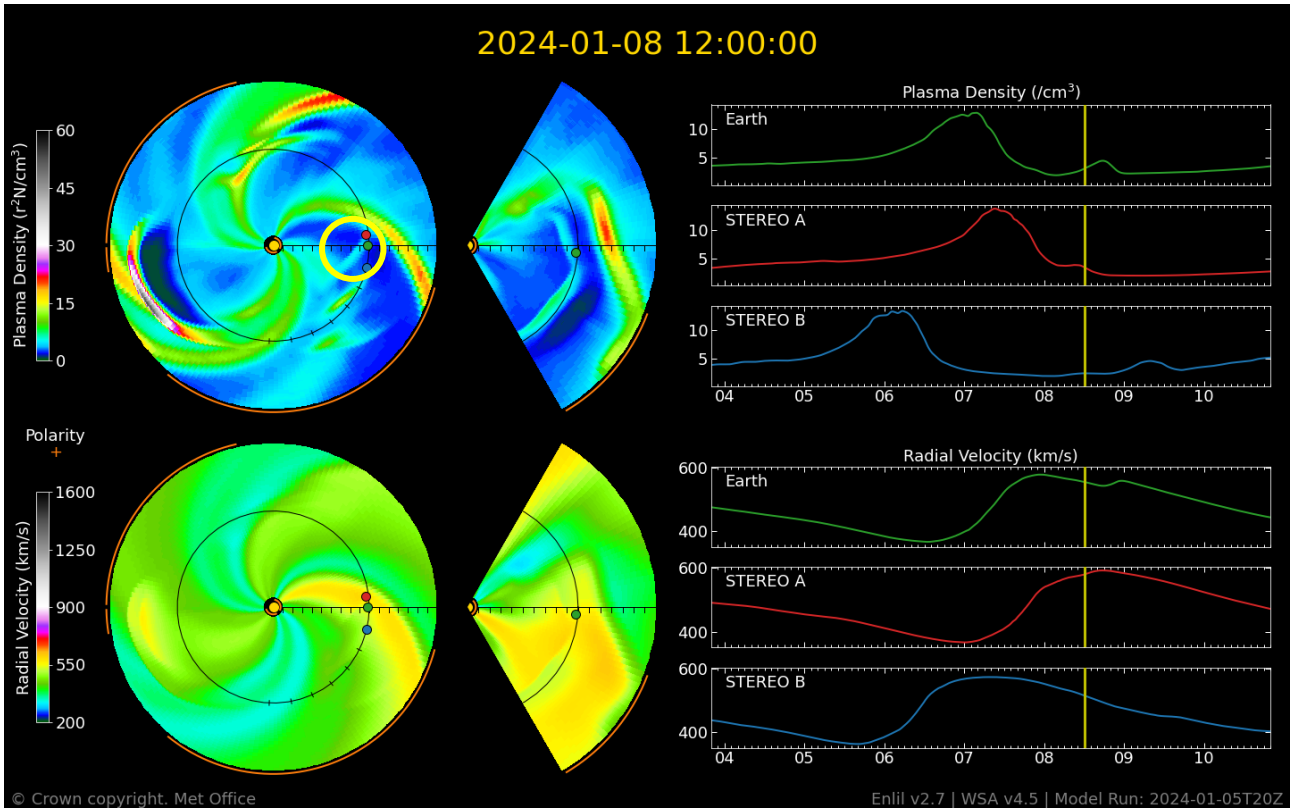
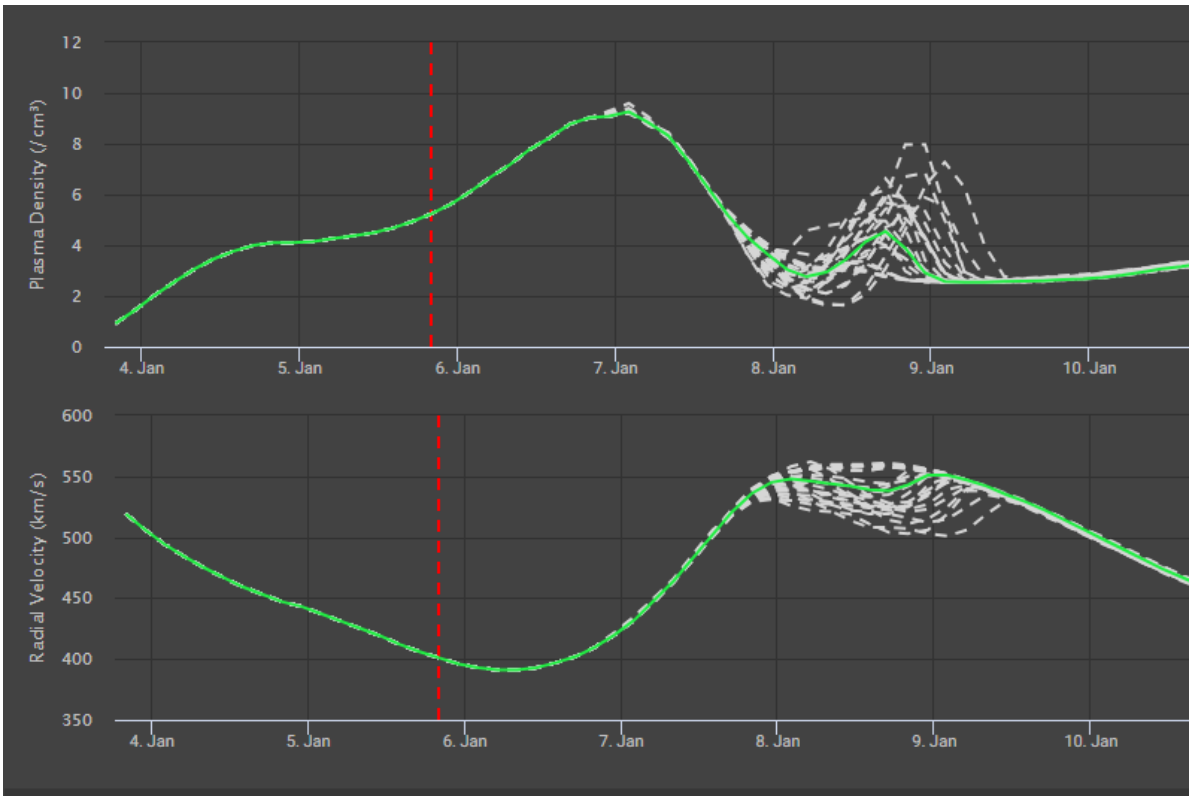


Figure 3: MOSWOC Enlil ensemble shows the range of CME arrival times.



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Radio Blackouts - X-Ray Flares:
Activity has been Low over the last 24 hours with the majority of activity observed from AR3534, AR3536 and AR3540, which is rotating onto the southeast quadrant. A filament eruption close to AR3536 late on 05 January, was associated with a C-class flare, which appears to have an Earth-directed component.

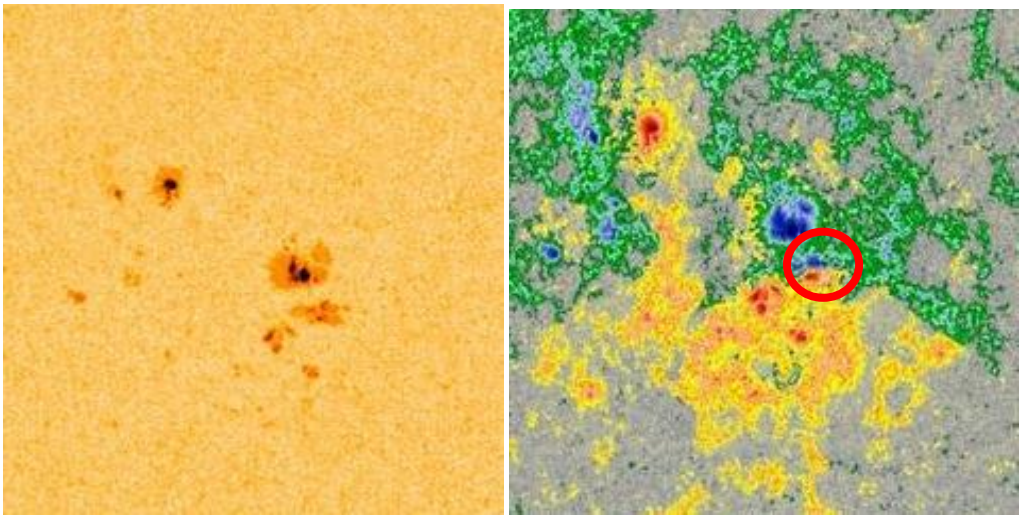
AR3536 is the most complex region on the disc with a persistent Delta spot in the central region, which appears to be a north-south alignment, with still enough energy to produce a significant flare. AR3538 in the north-centre disc is also complex with a beta-gamma configuration but is less active.

AR3540 which is currently rotating onto the southeast disc appears to show some magnetic complexity, although this is difficult to ascertain at present due to its viewing angle. The southern portion of this region has separated and is now the newly numbered AR3541, which shows a simpler Hsx/Alpha configuration. However, the close proximity of the two ARs may still produce a significant flare. There appears to be a lot of magnetic looping evident in the SDO/AIA 171 imagery above these two regions in the southeast.

Low to Moderate activity is forecast with a slight chance of X-class flare, mainly from AR3536 in the northeast and potentially from AR3540 rotating onto the southeast quadrant.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 4: SDO/HMI intensitygram (left) and Magnetogram (right) shows AR3536, with a delta spot (circled red).



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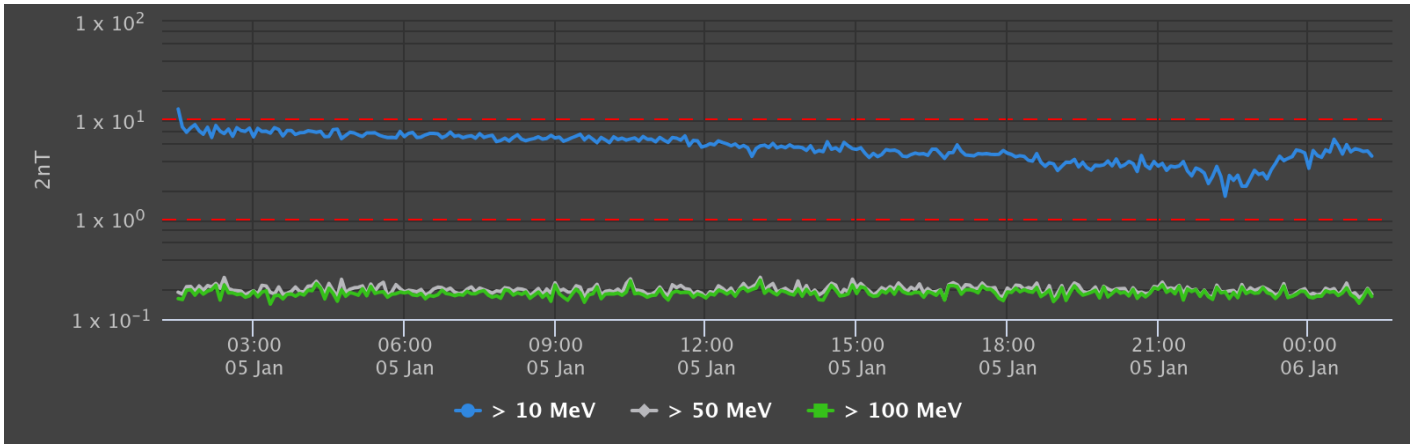
Solar Radiation Storms - (High Energy Protons):
GOES16 high energy (greater than 10MeV) proton flux is currently below the S1/Minor Storm threshold, on a steady downward trend.

There appears to have been a slight increase in low energy protons observed at ACE following the CME from the northeast quadrant. This CME is due to glance the Earth on 08 or 09 January, with a risk of further proton enhancements.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	30	40	40
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES-16 Proton Flux



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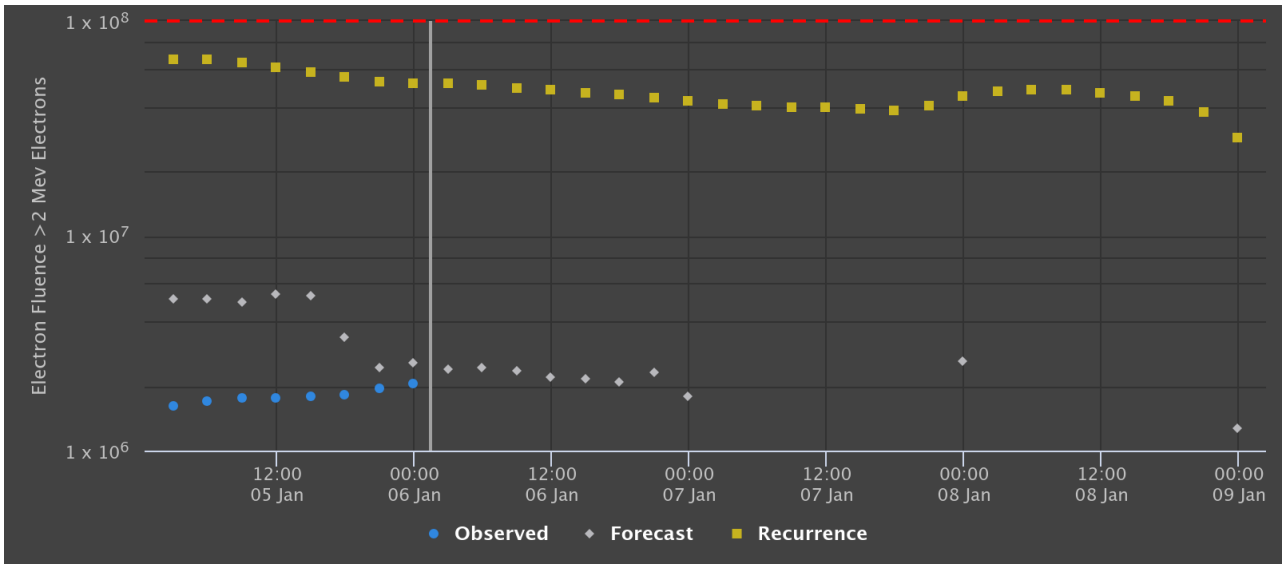
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is expected to be at background levels through 06 January in the presence of a benign solar wind environment. Uncertainty increases through 07-09 January as a potential coincident high speed stream and CME arrival could lead to an eventual increase in the electron flux. However, the precise timing and strength of each of the events will determine the timeline of increase and decreases in electron flux values.

Electron fluence values are well below the Active threshold. A rising trend may become evident later in the period should there be a sustain rise in flux levels. This is however subject to low confidence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: MOSWOC REFM electron fluence.



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